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Abstract :

The purpose of this paper is threefold. First, the paper provides a synthesis of the potentialities and limits of the dominant economic literature on vertical contractual relations which essentially focuses on the impact of vertical specialization and vertical integration on competition and customers' welfare. Second, the paper proposes a characterization of the different degrees of vertical specialization and vertical integration for key actors in the info-communications industry: equipment suppliers, telcos, ISPs/IAPs, navigation and software/middleware companies, information and content companies. Thirdly, the paper acknowledges a confrontation between, on the one hand, optimal vertical structures exhibited in dominant economic models and, on the other hand, observed vertical structures in the info-communications industry. From this confrontation emerges an important gap between theoretical results and observable trends. The outcome of this paper is thus that the dynamics between vertical relationships and competition requires a new research agenda, especially for researchers concerned with the evolution of the info-communications industry.

Key words: Vertical relations, competition, info-communications industry, innovation.

Introduction

Today, the vertical structure of the industry, and its impact on competition, appears as a key element in the understanding of the evolution of the industry. One of the distinctive features of the info-communications industry is that the development of a given activity is directly dependent on what occurs in upstream and downstream levels, on what suppliers and customers do. Over the recent years of liberalization, for instance, the performance of telecommunications operators was associated with the upstream provision of high-powered, multi-use equipment. The successful development of the Internet was also based on new relationships between telcos and ISPs/IAPs. Finally, the generation of secure and multi-content applications for high speed Internet and 3G mobile phones progressively involved closer relations between navigation and software/middleware companies, on the one hand, e-commerce, information and broadcasting companies, on the other hand.

The evolution of the industry can of course be affected by other key aspects – anti-trust, regulation, governance – which cannot be neglected. Nevertheless, a focus on the vertical theme can contribute to clarify (at least in part) past and current transformations of the industry. It also gives us the opportunity to provide a synthesis of the different analyses of these phenomena and, eventually, select the most promising framework to explore potential future transformations. This paper elaborates on this issue and concentrates on the related economic literature. Two main approaches can be distinguished. On the one hand, mainstream economics tends to extend basic models (oligopoly theory, agency theory) to incorporate the emergence of vertical contractual relations, and considers what occurs in the info-communications industry as potential illustrations of these models. On the other hand, evolutionary economics concentrates on observed vertical structures in the info-communications industry, and further derives some plausible and testable assumptions on their impact on competition and industry dynamics. In section 2 and section 3, the paper presents and discusses the respective results and methodologies of these two approaches. Section 4 presents both of these approaches to the key trends of evolution of the vertical structure of the info-communications industry over the last 20 years. This confrontation shows that there is generally an important gap between mainstream theoretical results and observable

trends of vertical integration/specialization. By contrast, the evolutionary approach offers a framework to analyze the dynamics of the info-communications industry. Section 5 concludes.

Vertical contractual relations: a review of a dominant framework and its applications

The literature on vertical contractual relations is part of the theory of contracts[1]. This literature focuses on the articulation between an upstream level (supplier) and a downstream level (client). Each level can be characterized by different degrees of competition (monopoly, duopoly, oligopoly), associated with different degrees of strategic behaviors and different structures of information. Strategic behaviors emerge as soon as there is more than one firm either at the upstream or downstream level, and essentially come in the form of fierce price competition among firms with the highest level of fixed/sunk costs, dedicated to force the exit rivals (real or potential, upstream or downstream). The more (respectively the less) similar are firms in terms of size or influence on the market, the higher (respectively the lower) strategic behaviors will be. Information also plays a key role since customers in the final market express a function of demand which is not always perfectly observable by key actors in upstream and downstream levels. Demand is evolving and the permanent discovery of new market niches (generally by downstream firms, which are closer to the market) can contribute to the emergence of imperfect information (at least for upstream firms). Perfect information on demand is only observed when final markets are highly standardized. Models of vertical contractual relations are generally classified according to simple features, namely the presence or absence of strategic behaviors and the presence or absence of imperfect information, which provide a basis for the analysis of the different industrial configurations experienced in the info-communications industry. Four different cases are thus considered: (1) low strategic behaviors, perfect information; (2) low strategic behaviors, imperfect information; (3) high strategic behaviors, perfect information; (4) high strategic behaviors, imperfect information. Readers not familiar with this literature will find a table summarizing the basic results and applications at the end of the section.

[1] The theory of contract is generally supposed to include different approaches : mainstream approaches (Tirole, 1988; Kreps, 1990), transaction costs theory (Williamson, 1985) and property rights theory (Hart, 1995). The present contribution provides a critical review of the first approach which is the most developed in economic

Sustainability of the industry structure

The different models of vertical contractual relations are based on a common assumption (for an exhaustive survey of these models, see Katz, 1989; Perry, 1989). Since the price paid by customers in the final market essentially reflects the high fixed/sunk costs of firms (located upstream or downstream, in charge of R&D, development of physical infrastructures, production of a basic commodity to be further developed and distributed), the industry structure is ultimately determined in large part by the market forces driving competition among these high costs firms. As such, these firms may have specific incentives to shape the industry structure (via vertical integration or via vertical specialization) in respect of their optimal strategy[2]. The problem is then to focus on the sustainability of a given industry structure when vertical contractual relations are taken into account, and to assess the outcome in terms of global competition and customers' welfare[3]. These models also rely on a common procedure. The first step is to determine the optimal strategy that rational players have to implement, high cost firms playing first. The second step is concerned with a comparative analysis of the potential vertical structures in terms of prices on the final and intermediate market, profits for each firm, and customers' welfare. The third step is to determine the existence of 'sufficient' vertical restraints, that is vertical restraints that may replicate the most efficient results obtained in the second step, either by vertical integration or vertical specialization[4].

Low strategic behaviours, perfect information

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theory. However, this critical review clearly necessitates to be extended to the two other approaches and will certainly motivate other papers in the near future.

[2] The role of customers is a key issue in current economic and business management debates (Stabell and Fjeldstad, 1998; Abbate, 1999; Ramirez, 1999). On the one hand, the argument is that the functioning of an industry is mostly supply-driven, with customers being considered as the passive recipients of the output provided by firms. On the other hand, some authors suggest that the industry (and especially the info-communications industry) is mostly demand-driven, or at least that the notion of value co-production where clients are involved in shaping the product rather than behaving merely as customers deserves a specific analysis. In mainstream economic models, the first option is generally privileged, with customers having to pay the price which is fixed by upstream and downstream firms.

[3] Sustainability here is to be considered in the following sense : the question is whether the existing vertical structure (for instance vertical specialization) is stable or whether, given the incentives and optimal strategy of high costs firms, this existing vertical structure tends to be replaced by a new (optimal) vertical structure (for instance vertical integration), imposed by high costs firms.

[4] Sufficient vertical restraints are : resale price maintenance, exclusivity, bundling, franchise fees, royalties. These specific contracts may – in isolation or in combination – replicate the results (i.e. price, quantity, profit, social welfare) of the optimal vertical structure (integration or specialization).

Low strategic behaviours occur when there is no price competition among high cost firms, and *a fortiori* when there is no competition among these firms (when there is a monopoly or a dominant firm). Perfect information means that all firms (upstream and downstream) perfectly observe changes in final demand which is relatively standardized. Because upstream and downstream firms develop their own (uncoordinated) strategies, a "double marginalization" problem appears: the opportunity for low cost firms (upstream or downstream) to capture a positive profit is perceived as a profit loss by high cost firms (respectively downstream or upstream) which did not expect this extra marginalization[5]. Consequently the existing separation between the upstream and the downstream levels generates a structural inefficiency. By contrast, vertical integration is the optimal organizational form because it corresponds to the maximization of the joint-profit of the now coordinated vertically-related units, minus the cost of integration. Moreover, the elimination of the double marginalization generates decreases in final prices, and customers' welfare improves when customers are exclusively reactive to price changes which directly affect their standardized demand. Vertical integration is thus superior to vertical specialization in this case, but sufficient vertical restraints exist.

This situation – which is described in Economides (1996), Laffont and Tirole (2000) – corresponds to the phase of pre-liberalization in telecommunications where both the equipment suppliers and telcos were national monopolies and essentially provided customers with standardized products and services (i.e., the Plain Old Telecommunications Services, or POTS, namely phone calls and fax). A specific application of these models is the US case. During the pre-liberalization period, AT&T was an integrated structure which regrouped the upstream activities (equipment supply, lower costs) and the downstream activities (network operation, higher costs). With vertical integration, double marginalization between the upstream level and the downstream level was avoided, and efficiency in the vertical structure was thus achieved.

Low strategic behaviors, imperfect information

In this case, an "information" problem is added to the "double marginalization" problem just discussed. For instance, low costs firms located downstream may observe directly the final

[5] The "double marginalization" issue is largely analyzed in the literature. See, for instance, the recent *Telecommunications Policy* paper by Park and Lee (2002) on the occurrence of such a problem in the Korean telecommunications industry.

demand, while the high costs firms located upstream do not. This second category of models can provide a more complex description of what occurs within the different levels especially when final demand is not perfectly standardized. Being closer to the final market, the downstream level can react more efficiently than the upstream firms to specific market demands, and further generate revenues from this informational advantage. For the upstream firms, this informational rent captured by downstream firms is considered as a profit loss. The main result of these models is that vertical integration remains the optimal structure for the high cost upstream firms because it allows the maximization of the joint-profit of perfect information. Vertical specialization, on the contrary, does not provide a solution to both negative externalities (double marginalization and information problems). Vertical integration increases customers' welfare by the elimination of the double marginalization, but may impose in the meantime a standardization of demand. Sufficient vertical restraints can contribute to eliminate the double marginalization problem (as in the preceding case), but have no effect on the information problem.

In a sense, this type of model can be considered as an extension of the first application to the telecommunications industry. This model includes the potential evolution of demand in the pre-liberalization era, with similar conclusions on the efficient structure (vertical integration).

High strategic behaviors, perfect information

When strategic behaviors are introduced within the high cost firms' level, an important change is observed in the models' structure. The optimal strategy is not the maximization of the joint-profit anymore. Because of the prevalence of threats and counter-strategies, the "dampening-effect-of-competition" is now the optimal strategy. This means that high cost firms, located upstream or downstream, will strategically modify the forces that drive competition within their own level in order to get a better control over key decision variables (namely prices in the intermediate and final market), and further capture strategic gains over competitors. In this context, the priority is to adopt the organizational structure which allows a sufficient degree of flexibility to act and react on prices. In this case, vertical integration is not the optimal organizational form : vertical specialization is superior to vertical integration. This involves for customers a decrease in surplus as prices can increase in the final market. On some occasions, vertical restraints may however replicate the results of vertical specialization.

This case broadly corresponds to the early stages of liberalization, and characterizes a situation where national monopolies (AT&T in the US, BT in the UK, for instance) were progressively faced with a limited number of new entrants (MCI and Sprint in the US, Mercury in the UK)[6]. These new entrants essentially provided standardized, long distance services and relied on the incumbents' infrastructure. These new entrants engaged in a fierce price competition against the incumbents. In this perspective, these early stages of liberalization can be considered as a typical illustration of a situation where strategic behaviors are present and information on final demand is perfect (Economides, 1996; Laffont and Tirole, 2000). In the US, this period coincides with the vertical separation of the upstream equipment supply from the downstream network operation by AT&T. What the models tell us is that this vertical specialization may be interpreted as the incumbent's strategy to adopt a flexible organizational structure (AT&T being separated from the equipment supplier Lucent) in a context of the increasing price competition from new entrants (MCI and Sprint).

High strategic behaviors, imperfect information

In this last category of models, a dilemma occurs: the presence of strategic behaviors favors a vertically specialized structure, while the existence of an information problem favors a vertically integrated structure. However, information problems are generally considered by high cost firms as dominant compared to price variations in these models. Consequently, vertical integration is preferred to vertical specialization. For customers, prices will be lower but there may be a risk towards standardization which affects (negatively) their surplus.

This case corresponds to the emergence of full competition in telecommunications, coupled with the development of an open set of new applications. Many new products and services are launched on the market (i.e. the 'Pretty Amazing New Services', or PANS such as toll-free numbers, name or number identification, voice messaging, routing of calls, data transfer, home banking, video on demand, videoconferencing, online services, telephony over the Internet, e-commerce and m-commerce), and considerable uncertainty emerges concerning the potential applications for customers on the final market. In the meantime, price and non-price rivalry occurs among the different firms involved in telecommunications but also in other related activities, such as the Internet, computing (hard and software), information and broadcasting. The huge vertical integration process occurring among these different types of

[6] This limited number of new entrants was imposed by the regulators.

firms is considered as a typical illustration of models where strategic behaviors are high and information on demand is imperfect (Economides, 1996; Gong and Srinagesh, 1996; Laffont and Tirole, 2000).

Basic results and applications

Mainstream economic approaches tell us that it is possible to determine an optimal vertical structure of the industry. Depending on the conditions of supply (degree and nature of competition) and demand (degree and nature of standardization), dominant economic models attempt to determine the organizational structure between the upstream and the downstream level which guarantees the best allocation of resources in terms of prices, quantities, profits and welfare. The optimal vertical structure of the industry basically depends primarily on the market structure (number of firms) and the cost structure (high or low fixed/sunk costs) which prevail in the vertically-related units of analysis (upstream and downstream levels), and which drive firms to adopt, or not, strategic behaviors in terms of price competition. The optimal vertical structure also depends on the information structure (perfect or imperfect) concerning final demand which command the opportunity for firms to make use of an informational rent (which results from an informational asymmetry between firms), and which reflects the degree of standardization of the final market.

In vertical contractual models, these determinants are expressed and synthesized by two simple criteria: (1) the presence or the absence of strategic behaviors; and (2) the presence or the absence of perfect information on final demand. The combination of these two criteria involves the analysis of four different cases which are summarized in Table 1 below. For each combination, the optimal strategy, the optimal vertical structure and the sufficient vertical restraints are expressed. Moreover, for each combination, an illustration of the applications to the telecommunications industry is provided. Namely, the first and second combination of criteria (low strategic behaviors, perfect/imperfect information of demand) provides formal models dedicated to describing the pre-liberalization era, where competition was non-inexistent and demand relatively standardized. The third and fourth combination of criteria (high strategic behaviors, perfect/imperfect information on demand) correspond to specific models with applications to the emergence of liberalization, where (price and non-price) competition was introduced and demand was more volatile.

Characteristics	Optimal strategy	Optimal vertical structure (with/without sufficient vertical restraints)	Applications to the info-communications industry
1) Strategic behaviors: Low Information on demand: Perfect	Maximization of joint-profit	Vertical Integration (with sufficient vertical restraints)	Pre-liberalization in telecoms
2) Strategic behaviors: Low Information on demand: Imperfect	Maximization of joint-profit with perfect information	Vertical Integration (without sufficient vertical restraints)	Pre-liberalization in telecoms
3) Strategic behaviors: High Information on demand: Perfect	Dampening-effect-of-competition	Vertical Specialization (with sufficient vertical restraints)	Early stages of liberalization in telecoms
4) Strategic behaviors: High Information on demand: Imperfect	Maximization of joint-profit with perfect information	Vertical Integration (without sufficient vertical restraints)	Full liberalization in telecoms

Table 1: Optimal vertical structures in mainstream economic theory

From the basic results and applications underlined in this presentation, it appears that some key elements remain beyond the scope of mainstream economic models. Firstly, the process by which the criteria (low/high strategic behaviors, perfect/imperfect information on demand) are modified over time is essentially given and, consequently, this process remains unexplained. In fact, mainstream economic models provide a comparative analysis of different static pictures of the industry, rather than a dynamic understanding of the evolution of the industry. Secondly, the intrinsic meaning of these criteria is questionable. Strategic behaviors, on the one hand, are reduced to the existence of a fierce price competition among firms, while the process of competition would more broadly require an analysis of the strategic behaviors in terms of improved techniques of production or products, in R&D or in advertising expenses, in the engagement of new productive or distributive activities or in the imitation of existing activities, in the implementation of new forms of organization in which customers, suppliers, partners and even competitors are directly involved[7]. In the meantime, the statement of a perfect information on demand (as well as the reduction of imperfect information to something which is observed by some players and not by others) is schematic, and increasingly contested in recent economics and strategic management developments[8]. Thirdly, by focusing on some specific actors in the industry (especially the telcos, which are generally considered as the key actors), as well as on some specific periods of time (broadly defined by the distinction pre-liberalization/post-liberalization), these models overlook the factthat the industry is in fact composed of a number of vertically-related actors (equipment

[7] See Krafft (2000).
[8] See Fransman (1999) ; Swan, Newell, and Robertson (1999) ; Mahler and Rogers (1999).

suppliers, telecommunications operators, ISPs/IAPs, navigation and software/middleware companies) which all played a key role in the step-by-step transformation of the industry. These three elements are key issues for researchers concerned with the analysis of the evolution of the info-communications industry, and have to be introduced in the analysis.

Evolution of the info-communications industry: an analysis of the observed trends of vertical integration/specialization

Besides mainstream economics, another part of the economic literature has focused on the determinants of the evolution of industry (Loasby, 1991; Langlois and Robertson, 1995; Teece, 1996; Malerba and Orsenigo, 1996; Richardson, 1998; Foss, 1997). The development of this alternative framework, inspired by early authors such as Marshall and Schumpeter, is structured by a clarification of what 'Industrial evolution' really means, and what type of research is involved in this case. Industrial evolution focuses on the way in which the activities undertaken within the economic system are divided up among firms: some firms embrace many different activities while, for others, the range is narrowly circumscribed; some firms are large and others are small; some firms are vertically integrated but others are not. Industrial evolution not only describes and analyses how the industry is organized now, but also how it differs from what it was in earlier periods: what forces were operative in bringing about this reorganization of the industry and how these forces have been changing over time. Industrial evolution is crucial for understanding the coherence that exists within a specific industry – for instance, what determines its boundaries, who does what and why within the industry, and what forces are central to its functioning – as well as the diversity which may be observed among different industries.

This approach is motivated by an inductive methodological reasoning, while mainstream economic models are essentially deductively-oriented. This means that, on the one hand, the evolutionary approach attempts to capture some regularities in observed phenomena and elaborates on this basis some plausible and testable assumptions to understand these regularities; while, on the other hand, mainstream economic analysis first concentrates on formal models to develop some concrete applications. This involves that, on the one hand, the evolutionary approach privileges the analysis of the process by which a given trend of

evolution has been achieved; while, on the other hand, mainstream economic models consider real-world phenomena as potential illustrations of their optimization programs[9].

In what follows, this framework (and related methodology) will be applied to the evolution of the info-communications industry. Because the info-communications industry is so complex, this framework will be supported by a layer model in which the activities and capabilities of firms are central. In fact, this evolutionary layer model refers directly to the process by which firms have to develop their capabilities and, consequently, have the opportunity to move from one activity to the other, i.e. from one layer to the other. Moreover, the layer model functions as a guideline to analyze how the different degrees of vertical specialization/integration evolve over time, for the different actors involved in the info-communications industry.

The info-communications industry layer by layer

Layer models are widely used in the computing and telecommunications fields, generally to decompose a complex technological system into coherent, simple, and connected subsystems (see for instance Noam, 1983; Kavassalis, Lee and Bailey, 1998).

Here, the different layers refer more importantly to groups of firms in horizontal and vertical interaction, these firms undertaking different activities on the basis of the development of specific capabilities (Fransman, 1995, 2001, 2003). Layers are based on the similarity and the complementarity of the activities undertaken by firms. A layer re-groups firms undertaking some activities which require the same pool of capabilities in their implementation. If the activities undertaken by firms do not require similar capabilities, but rather complementary ones (e.g. vertically-related ones), different vertically-related layers can be defined. Within this activity-based layer model, firms interact on the basis of a large spectrum of relationships from pure market connections to complex cooperation agreements and alliances. Firms within a layer are not confined to pure market connections, but may also develop cooperation agreements and alliances. Firms composing the different vertically-related layers are not

[9] For some discussion on that point, see basic references such as Kaldor (1985) and Hayek (1937). More recently, Fisher (1991) on a review of the *Handbook of Industrial Organization*, edited by Schmalensee and Willig in 1989. According to Fisher, mainstream analyses of industrial organization are 'exemplifying theory', while the author advocates that what is really needed is 'generalizing theory'. This involves critical issues when the confrontation to facts is operated. Mainstream analyses do not provide robust conclusions, but essentially "formalized anecdotes" (ibid, p. 207). This results in a fragmented vision of problems, in a typology of possible equilibria and behaviors, which essentially tells us that "anything can happen" (ibid, p. 207). In this respect, these models fail to provide useful guidelines to analyze real-world situations (ibid, p. 209).

necessarily in a buyer-seller relationship, but may also be considered as suppliers and clients engaged in a long-term relationship, as divisions within the same firm. It is possible to decompose the industry into the following different layers[10].

Layers	Activities	Firms
Layer 1	Equipment provision	Equipment suppliers: Lucent, Alcatel, NEC, Nortel, Cisco, Nokia
Layer 2	Network operation/management and associated services provision	Telecommunications carriers: AT&T, France Telecom, BT, Deutsche Telekom, NTT
Layer 3	Internet connectivity and associated services provision	IAPs and ISPs: Wanadoo, Freeserve, T-online
Layer 4	Navigation and software/middleware provision	Browsers, data protection companies: Netscape, Yahoo!, Excite
Layer 5	Content provision	E-commerce, broadcasting and information companies: AOL-Time Warner, Vivendi Universal

Table 2: The info-communications industry decomposed into vertically-related sub-systems

The 'equipment provision layer' (Layer 1) regroups firms (equipment suppliers) specialized in the development of switches, transmission equipment, routers, servers and billing software. Within this layer, competition comes from the interaction between incumbents such as Lucent (previously owned by AT&T), Alcatel, Siemens, Nortel, NEC and new firms such as Cisco, BayNetworks, Ascend, Nokia and Ericsson coming from the development of Internet and mobile activities. In the recent past, this competition tended to produce waves of mergers between the two categories of firms, especially from incumbents towards new firms: see for instance acquisitions such as Lucent-Ascend, and Northern Telecom-Bay Networks, now Nortel. Layer 1 provides Layer 2 with the equipment dedicated to network operation and management in the domain of fixed and mobile telephony, the Internet and multimedia.

The 'network operation/management and associated services layer' (Layer 2) regroups network operators (telecommunications carriers) involved in activities such as the provision of fixed and mobile telephony infrastructures and services. Within this layer, incumbents (AT&T, France Telecom, Deutsche Telekom, BT, NTT) had to face competition from entrants (Worldcom, Cegetel, Mannesmann, Mobilcom, Vodafone), the entry of which was

[10] See http://www.telecomvisions.com; and Fransman and Krafft (2002). For an in-depth analysis of the uses and limitations of such a layer model, see also Fransman (2002). More generally, the activity-based layer model is related to other complementary approaches, such as the Schumpeterian competence blocks developed by Palmberg (2002), or the recent value chain developments by Sabat (2002) and value networks framework by Li and Whalley (2002).

favored by liberalization and the development of new modes of communications (Internet and mobile). Entrants generally performed well and eventually acquired previous entrants (see Worldcom-MCI, even if this acquisition is highly contested today). Layer 2 provides Layer 3 with the infrastructure necessary to Internet connectivity.

The 'internet connectivity and associated services layer' (Layer 3) regroups firms (Internet access providers and Internet service providers) involved in Internet backbone provision and Internet service provision (e-mail, web hosting) activities. These firms appeared in the industry because of the increasing development of the Internet. However, there is a great heterogeneity among these firms: some of them are facilities-based while others are facilities-less; some of them are large and increasingly diversified while others are small and exclusively specialized; some of them provide free Internet services while others provide more sophisticated services and charge customers for that. Recent observations show that exclusively specialized, facilities-less, and free Internet companies tend to perform less successfully than others, and eventually exit the market or are acquired (AOL, for instance, exits Layer 3 and consolidates its activities in Layer 4 and Layer 5 by the acquisition of Netscape and Time Warner; Freeserve, the UK free Internet service provider, has been acquired by France Telecom via Wanadoo). Layer 3 provides Layer 4 with Internet connectivity, a basic commodity which can be complemented by value-added services.

The 'navigation and software/middleware layer' (Layer 4) regroups firms involved in search engines, browsers, portals, security electronic payment, firewalls and data protection services. Highly connected to the Internet revolution, most of these firms appeared relatively recently in the industry. However, because this layer is directly related to the computing and software activities, older established computer and software companies such as IBM and Microsoft are also present in this layer but tend to be less efficient than new firms such as Netscape, Yahoo, Copernic and Excite. Layer 4 provides Layer 5 with a new medium, the Internet, the applications of which have to be developed and distributed.

The 'content layer' (Layer 5) re-groups firms involved in activities including web design, online services, e-commerce, information services and broadcasting services. Within this layer, a large diversity of firms competed over the recent period. On the one hand, small new firms specialized in web design and e-commerce (the 'dot-coms', one of the most specific example being Amazon) performed at first incredibly well, but later encountered a shift in

their financial performance and continuing competitiveness. On the other hand, older established information and broadcasting firms diversified their activities into the Internet activities and penetrated then the 'content layer' of the info-communications industry (see Bloomberg, Reuters, and Time Warner). Layer 5 provides the customers with a large spectrum of diversified (secure and multi-content) Internet services.

Specialization and integration between layers

A key specificity of the evolutionary layer model is that, apart from a detailed description of each layer considered as an isolated system which essentially underlines the horizontal interactions between firms, an investigation in the nature of the vertical interactions between layers is also possible[11]. Let us focus, first, on Layer 1 which tends to be vertically specialized since the early stages of liberalization in telecommunications; second, on Layer 2 and 3 which experienced first vertical specialization, turned later to vertical integration and finally seem to renew with vertical specialization; and third, on a recent trend towards vertical integration observed between Layer 4 and Layer 5.

The early trend towards vertical specialization: equipment suppliers and telcos

Before liberalization in telecommunications, and well before the Internet and mobile revolution (before the mid-1980s to the mid-1990s), equipment suppliers experienced different types of vertical structures with their clients, the telcos, at that time monopolies. Fransman (2001) stresses that, in the US, vertical integration was predominant: AT&T, the incumbent telco, controlled the network equipment, the operation of the infrastructure and the provision of simple and standardized telecommunications applications (essentially voice calls, fax, or POTS for Plain Old Telecommunications Services). In Europe, on the contrary, the dominant vertical structure corresponded to vertical specialization with bilateral monopolies: in France, Alcatel was the unique equipment provider of France Telecom, the incumbent telco; and in Germany, the structure was very similar with Siemens and Deutsche Telekom[12]. Vertical specialization was also observed in Japan, but the incumbent telco NTT was provided by a group of both competing and cooperating equipment suppliers.

[11] The analysis is here limited to some large industrialized countries (the US, the UK, France, Germany and Japan). Of course, the situation may be different elsewhere. This does not necessarily involve that the layer model is inapplicable to other countries.

[12] For some time, however, BT (and its precursors) owned its own manufacturing operators. In France, also, PTT was an integrated Post, Telecoms and Engineering entities (for a detailed analysis, see Thatcher, 2000).

With liberalization first on equipment provision, and later on telecommunications services and infrastructures, a number of new firms appeared both in Layer 1 and 2. Incumbent equipment suppliers then had many new potential customers (the new telcos, the new entrants) but also had to face competition from new equipment suppliers. Since the mid-1990s, vertical specialization then appeared as the dominant vertical structure in most countries (see also Fransman, 2001). In the US, AT&T reorganized its equipment provision activities into a new and independent company, called Lucent Technologies. In Europe and Japan, the pre-existing vertical specialization persisted. From the early stages of liberalization, then, equipment suppliers became exclusively specialized: the penetration of these firms in other layers has been a transitory phenomenon; similarly, the penetration of firms from other layers within Layer 1 was also very rare. This vertically specialized structure was resistant to further changes, and especially to the Internet and mobile revolutions. The emergence of a diversified demand (or PANS for Pretty Amazing New Services), generated by the open set of applications that these new technologies could provide, essentially involved an increased concentration within Layer 1 (incumbent equipment providers soon acquired new firms which successfully developed radically new equipment systems for the Internet, especially in the optical fiber domain: see Lucent-Ascend, and Nortel), but no radical modifications concerning the vertical structure.

The evolving trend between vertical specialization and vertical integration: telcos and ISPs/IAPs

Layer 3 really appeared in the early 1990s when the development of the world-wide-web allowed a multiplicity of new services such as data transmission, e-commerce and the development of web sites. At that time, vertical specialization was predominant: ISPs/IAPs, as autonomous firms independent from telcos, contributed directly to the development and diffusion of the Internet. In fact, the technical separation between the network and the potential services (the TCP/IP interface) offered implied that these ISPs/IAPs could simply lease the infrastructure from network operators, or develop on it some points of presence to connect their customers end-to-end (see Kavassalis, Salomon and Benghozi, 1996). Moreover, even if some telcos such as MCI and Sprint early penetrated the Internet business as Internet backbone providers, most of them appeared as latecomers in this activity. This was then the opportunity for many small new firms to prosper and play a key role in the early stages of development of the Internet (see for instance the case of Freeserve in the UK).

Nevertheless, this role has significantly slowed down over time, and especially since the mid-1990s. Many telcos finally penetrated the connectivity market essentially by vertical integration, that is either by developing Internet activities internally or by acquiring existing ISPs/IAPs (France Telecom, the French incumbent telco, penetrated this business activity first by the creation of an internal division called Wanadoo, and second by the merger between Wanadoo, now an independent company, and the UK ISP Freeserve). In fact, Internet access and many Internet services (such as e-mail and web hosting) were becoming a commodity business driven by economies of scale and scope essentially captured by telcos. Moreover, the advent of free Internet access was robbing ISPs/IAPs of much of their revenues and making it increasingly difficult to differentiate themselves. While content may have been a key differentiator (as big ISPs/IAPs such as AOL recognized), the cost of differentiated high-demand content was prohibitively high for many smaller ISPs/IAPs. Finally, the development of high speed Internet certainly favored facilities-based companies such as telcos compared to many facilities-less ISPs.

Vertical integration was then the emerging vertical structure until the late 1990s. However, recent decisions by telcos to reorganize their Internet activities into an independent structure, eventually listed on stock markets, tended to favor the rebirth of vertical specialization over the last two years. In the US, for instance, AT&T decided to divest itself into different independent entities, one element of which will drive the Internet activities. In Europe, BT was divided into BT Retail, BT Ignite, BT Wireless, Yell, BT OpenWorld, and Netco (which never finally emerged). France Telecom and Deutsche Telekom also implemented important restructurings, with the introduction on stock markets of their Internet divisions, now structured within a specific company (eg France Telecom with Wanadoo-Freeserve, and Deutsche Telekom with T-online). While the reasons behind these different restructurings are quite diverse, more or less pressured by investors and financial markets, the outcome is an increasing vertical specialization between Layer 2 and Layer 3.

The recent trend towards vertical integration: navigation, software/middleware and content companies

In a first period (from the mid 1990s to the late 1990s), firms specialized in activities such as navigation, software/middleware, information and broadcasting activities. Each contributed in a rather independent way to the development of the info-communications industry. In fact, these firms were all engaged in the development of the Internet and associated applications,

but their core activities were related to industries previously separated: computer industry (hardware and software), press, information, and broadcasting (TV and radio programs). The development of data transfer was one of the first opportunities for these different firms to develop closer links between themselves, as soon as requirements in terms of security and reliability emerged from customers (essentially big companies). Apart from this specific case, basic demands from customers were essentially reduced to standard applications such as e-mail, and considerable uncertainty was observed concerning the development of more sophisticated content applications (e-commerce, m-commerce, etc.). In this context, the relationships between firms undertaking activities such as navigation and software/middleware, information and broadcasting, tended to be vertically specialized.

In a second period (since the late 1990s), with the development of e-commerce, m-commerce, and the emergence of new services (secure and multi-content applications) associated with the high speed Internet, the info-communications industry regrouped firms involved in a more direct connection. Even if the characteristics of final demand were still highly uncertain, firms progressively tended to strongly coordinate the different (vertically-related) value-added services they could provide to customers, essentially by resorting to vertical integration. For instance, large ISPs previously involved in Layer 3 tended to exit this layer and consolidate their activities in Layer 4 and Layer 5 (see for instance the successive acquisition by AOL of Netscape, the browser, and Time Warner, the broadcasting company). Some firms formerly exclusively involved in mobile telephony (Layer 2) tended to move also towards Layer 5 (Vivendi-Universal, despite a somewhat chaotic evolution). Finally, some firms like Microsoft with MSN were present both in Layer 4 and Layer 5.

Summing up

The evolutionary model structures the info-communications industry into different layers, stresses what type of firm is to be included within the different layers, and characterizes period by period the evolution of the processes of vertical integration/specialization that occurred among firms located in different layers. The evolutionary approach goes beyond the conventional distinction between pre-liberalization/post-liberalization, and breaks up these large (and vague, to some extent) periods into shorter time spans where the role of the different key actors in the step-by-step transformation of the info-communications industry is clarified. Table 3 below sums up the different results which are obtained in terms of the

observed vertical structures in the info-communications industry, using the layer model as a guideline.

Layers composing the info-communications industry	Periods	Observed vertical structure
Layer 1 and Layer 2	Period 1: Before mid 1980s to mid 1990s	Diverse: US: Vertical Integration EU: Vertical Specialization Japan: Vertical Specialization
	Period 2: from mid 1990s	Vertical Specialization
Layer 2 and Layer 3	Period 1: from early 1990s to mid 1990s	Vertical Specialization
	Period 2: from mid 1990s to late 1990s	Vertical Integration
	Period 3: from late 1990s	Vertical Specialization
Layer 4 and Layer 5	Period 1: from mid 1990s to late 1990s	Vertical Specialization
	Period 2: from late 1990s	Vertical Integration

Table 3: Observed vertical structures in the info-communications industry

The contribution of the layer model to the understanding of evolution of the info-communications industry could certainly be improved by an in-depth analysis of the role of the trailing stock phenomena, governance and related business strategies (mergers and acquisitions, outsourcing), especially since the beginning/end of the periods which are here considered to characterize the processes of vertical integration/specialization, are not independent of these phenomena[13]. The layer model, nevertheless, clarifies how some firms can enter into a specific layer, evolve within this specific layer, and eventually penetrate other layers either directly or by the development of some modes of coordination with other firms (cooperation and alliances, mergers and acquisitions). Finally, this layer model is useful for the identification of the process by which firms outperform their competitors, for a long or more transitory period.

[13] These elements are crucial in the dynamics of the info-communications industry. Clearly, the development of stock markets, combined with the diffusion of corporate governance principles within key companies of the info-communications industry, motivated most of the strategies of consolidations and cessions of activities that were observed over the last five years, in Layer 1 to 5. These elements are not explicitly included in the analysis at the moment, although some comprehensive analysis exist in the literature. I refer directly to the analysts reports are available on this theme (especially those from Stern Stewart, Salomon Smith Barney and McKinsey), and also to key contributions from academics (Lazonick and O'Sullivan, 2000) which document and analyze how the financial and industrial logics interact.

Confrontation between optimal vertical structures and observed vertical structures

The two preceding sections provided us with distinct series of results, based on distinct frameworks. Now, key questions have to be addressed: which framework is the most reliable to analyze the transformations of the info-communications industry? Which one captures best the key trends in vertical integration/specialization over the last 20 years? To answer these questions, these approaches will be confronted. Table 1 and Table 3 reflect the results and related-methodology which structure respectively mainstream economic models and the evolutionary layer model. Table 1 (and thus mainstream economic models) operates in the following way: the characteristics of the industry (presence/absence of strategic behaviors; presence/absence of perfect information) are defined => the optimal strategy is calculated => the optimal vertical structure (with or without sufficient vertical structures) are determined => applications to the info-communications industry are derived. Table 3 (and thus the evolutionary approach) works in a different (opposite, to some extent) sense: the layers composing the info-communications industry are defined => the key periods of evolution are determined => the observed vertical structures are analyzed. The confrontation will be carried out first on Layer 1 and 2, second on Layer 2 and 3, and third on Layer 4 and 5.

Equipment suppliers and telcos

Observed vertical structure versus optimal vertical structure

Periods	Observed vertical structure	Optimal vertical structure
Period (1): **Before mid 1980s to mid 1990s**	Diverse: from Vertical Integration to Vertical Specialization	Vertical Integration (with Sufficient Vertical Restraints)
Period (2) **From mid 1990s**	Vertical Specialization	Vertical Integration (without Sufficient Vertical Restraints)

Table 4: Vertical structures experienced in Layer 1 and Layer 2

The confrontation between observed vertical structures in the info-communications industry and optimal vertical structures exhibited in models provides some contrasting results (see Table 4).

Concerning the first period, observations show that a large spectrum of vertical structures were experienced between Layer 1 and Layer 2, from vertical integration to vertical specialization. On the other hand, mainstream economic models indicate that, within this period which is indeed characterized by (a) low strategic behaviors among national monopolies, and (b) perfect information on a standardized demand, the optimal structure is vertical integration (while sufficient vertical restraints may also exist). Over the first period, then, a gap occurs between what is observed within the industry (with a large diversity of the vertical structures implemented by firms), and what is recommended within the literature on vertical contractual relations (with a convergence towards vertical integration).

Concerning the second period, moreover, observations show that vertical specialization seems to be the dominant vertical structure in practice. But, mainstream economic models show that, since this period is characterized by (a) high strategic behaviors among incumbents and entrants, and (b) imperfect information on demand which is now evolving and diversified, the optimal structure is vertical integration (without sufficient vertical restraints). For the second period, thus, conclusions obtained from mainstream analyses diverge dramatically from what is observed in practice.

Comments

a) Comments on period (1)

Different assumptions can be employed to explain the gap between observed vertical structures and optimal vertical structures in period (1). The first assumption is that vertical integration within AT&T of both the activities of equipment provision and network operation/management was at that time the only efficient vertical structure, the other observed structures being considered as 'accidents of history'. This assumption in favor of mainstream economic models is rather extreme in the sense that, to sustain this assumption, we should clearly provide evidence on the sub-optimality of the European and Japanese systems. For instance, it should be demonstrated that prices charged in the US final markets were significantly lower than elsewhere, or that US innovations were clearly superior. These elements are not supported by historical facts, and the different systems were comparable to some extent: prices were decreasing more rapidly in the US, but innovation in most industrialized countries was driven by celebrated and efficient research centers (Bell Labs in the US, CNET in France, Electrical Communications Laboratories in Japan) which all initiated long-term research programs on digital switching, optical fiber, cellular mobile

systems, packet-switched networks, or satellite communications. In fact, the US vertically-integrated system is more likely to be considered as a US distinctive feature, or more precisely as a 'Bell system' feature, highly history-dependent[14].

The second assumption is that vertical structures observed in Europe and Japan are in fact specific examples of the vertical restraints which approximate to the results of (optimal) vertical integration. Nevertheless, and because of the sufficient vertical restraints being involved in this case, we should demonstrate then that equipment suppliers were able to set prices on final markets. Here again, this point is not evident, and this second assumption is also extreme. Basically, this assumption overestimates the strength of equipment suppliers which were not at that time the industry leaders either in terms of R&D or on strategic programs. It was the telcos, with their project-oriented research centers, which played a key role on the generation of new products and further controlled final markets. As a matter of fact, the evolution of equipment suppliers' R&D expenses (as reported in Annual Reports) shows that this item increased significantly after liberalization, and not before[15]. In this context, it remains difficult to consider – as mainstream economic theory suggests – that the upstream level (here then the equipment suppliers) was in such a position to shape the industry structure, and that double marginalization was the key problem in the interactions between telcos and equipment suppliers.

The third assumption is that the explanation of the diversity of vertical structures observed in period (1) goes well beyond the vertical contractual relations framework. As a matter of fact, the different observed systems had their own coherence, largely dependent on history and on the temporal development of activities and capabilities, and were then logically distinct from one country to the other. For instance, AT&T was vertically integrated for more than a century, and this vertical integration was a key characteristic of the Bell system. The equipment division of AT&T was essentially specialized in the development and mass production of network equipment and customers premises, the fundamental and long-term research on potential products and processes being undertaken within the Bell Labs. In other

[14] Fransman (1995, p. 24) notes that "from the time that Alexander Graham Bell co-operated with the instrument-maker Thomas Watson in producing the first telephone sets, it was the same organization that both developed the telecommunications network and developed and manufactured the equipment that it required. This pattern was established in 1880, when the American Bell Telephone Company purchased Western Union's telephone supplying subsidiary, the Western Electric Company of Chicago". This pattern thus persisted until 1995.

[15] See Fransman (2001, 2003).

countries, the equipment suppliers were engaged in a large spectrum of activities, including electric and electronics activities for energy, space, defense and the telecommunications industry. In a sense, these firms applied a limited set of their capabilities to the telecommunications industry, in order to meet the development and manufacturing requirements from telcos. Even if this country/history specificity appeared as predominant for earlier periods of time, we should not neglect the fact that there was also some space for a further evolution of the different systems towards vertical specialization, especially from the mid 1990s. In this perspective, the US case provides an example of the discontinuities and ruptures that firms can impose by their strategic choices on a pre-existing (highly history-determined) pattern of activities and capabilities.

b) Comments on period (2)

Concerning period (2), a new set of assumptions can be formulated to characterize the gap between observed and optimal vertical structures. The first radical assumption is to consider, in respect to mainstream results, that the generalization of vertical specialization is a specific example of convergence towards a sub-optimal structure of the industry. This assumption, however, would clearly neglect the fact that this specific vertical structure has proved its viability over time. By this vertical specialization, some companies such as Lucent, Nortel, Alcatel, Motorola or Siemens refocused their activities on telecommunications and the Internet, eventually becoming key actors in the equipment provision business activity, and appeared as early innovators in new technologies such as optical fibers. By this vertical specialization, also, some new companies, such as Cisco, Nokia, and Ericsson, could emerge and perform incredibly well in the mobile equipment business activity. Finally, from this vertical specialization, competition at the downstream level was also fostered. Fransman (2001) shows that new telcos could compete successfully against incumbent telcos because at the upstream level some firms provided them with adequate technologies and networks. In fact, "the availability of specialist suppliers has significantly lowered technology barriers" (Fransman, ibid, p. 15). Vertical specialization clearly sustained the competitive process initiated by liberalization both in upstream and downstream levels, and cannot thus be considered as inefficient as is suggested by mainstream results.

The second assumption relies on a revised analysis of basic mainstream results. In fact, the convergence towards vertical integration would only be valid in mainstream economic models if products sold on the final market were close substitutes. It is true that over the liberalization

era both equipment suppliers and telcos tried in their respective levels to differentiate themselves from their competitors, and to offer specific products and services to end-users. For instance, when the mobile and Internet revolution appeared, some equipment suppliers and telcos gained a significant competitive advantage by offering reliability, friendliness, and diversity to customers. However, it seems also that key actors in telecommunications now provide a large spectrum of similar products and services and consequently differentiation opportunities are becoming relatively narrow. Essentially, new requirements such as QoS and billing systems which were developed initially by dynamic new telcos diffused rapidly within the info-communications industry and were soon imitated by key actors in the sector, especially incumbents. Furthermore, the acquisition of Orange by France Telecom provides an example of the capacity of traditional incumbent telcos to integrate early innovators in the domain. In this context, the argument of the non-substituability of products and services offered by telcos – which may sustain analytically the ultimate convergence towards vertical specialization and thus refute the predominance of vertical integration – is not necessarily supported by recent observations.

The third assumption is that, here again, the analysis of complex relationships between telcos and equipment suppliers through double marginalization problems is reducing. In fact, what appears more clearly is the emergence of distinct domains of activities, based on complementary capabilities. On the one hand, equipment suppliers significantly developed and refocused their capabilities. The provision of network and equipment for telecommunications and the Internet became their core activity, and this emerging specialization was supported by the cession of the different divisions and subsidiaries related to other activities (especially electric and electronics). The dependence in favour of telcos was also radically slowed down. In fact the equipment suppliers decided to transform their capabilities which remained essentially related to the development and mass production activities, into new capabilities which were more related to fundamental research and innovation activities. Since the mid 1990s, they massively invested in R&D, and thus became the leaders of the info-communications industry in terms of innovation. In the meantime, they successfully diffused these innovations into the downstream level (the telcos' level) by offering tailor-made applications to new entrants, applications associated with a large spectrum of assistance and maintenance services. On the other hand, since there was a fierce competition on prices, but also on capacities with the increasing traffic and diversified applications related to the Internet, telcos essentially engaged in high investments in network

infrastructures, end-to-end connections, and POPs. Incumbent telcos, which previously controlled most of the research activities, significantly reorganized their R&D divisions by the reallocation of employees towards other divisions (mostly commercialization and marketing). Incumbents voluntarily delegated these innovation activities to the equipment suppliers, and altered their set of capabilities in this domain. This occurred in a context in which new entrants entered the industry without any R&D activities and related capabilities, but nevertheless generated high revenues from the persistent growth in demand, and eventually outperformed the incumbents for a transitory or more permanent period.

Telcos and ISPs/IAPs

Observed vertical structure versus optimal vertical structure

Periods	Observed vertical structure	Optimal vertical structure
Period (1) **From early 1990s to mid 1990s**	**Vertical Specialization**	**Vertical Integration (without Sufficient Vertical Restraints)**
Period (2) **From mid 1990s to late 1990s**	**Vertical Integration**	**Vertical Integration (without Sufficient Vertical Restraints)**
Period (3) **From late 1990s**	**Vertical Specialization**	**Vertical Integration (without Sufficient Vertical Restraints)**

Table 5: Vertical structures experienced in Layer 2 and layer 3

This second confrontation also provides some contrasting results (Table 5). For the first period, there is a significant gap between observed and optimal vertical structures; for the second period, there is a coherence between the two; for the third period, observed vertical structures diverge dramatically from optimal vertical structure.

Comments

a) Comments on period (1)

Vertical specialization seems to be the dominant vertical structure in practice; while in mainstream economic models the optimal structure is vertical integration (without sufficient vertical restraints), since this period is characterized by (a) high strategic behaviors among many new ISPs/IAPs, and (b) imperfect information on the profitable opportunities of the Internet. The gap between observed and optimal vertical structures can be attributable to different elements.

The first assumption is that period (1) is basically a transitory one. In fact, even if double marginalization problems were emerging at that time, telcos were relatively passive on this specific problem. The picture of the incumbents' relative inertia in the face of new market opportunities is well documented in the literature, in which fast movers are generally described as small and new companies. Another complementary element is that interconnection agreements were based, from the origins of development of the Internet, on a specific pricing regime called 'peering' (Srinagesh, 1997). The peering system stated that a given company could freely use the network of another company, provided that a reciprocity agreement was respected[16]. This system which was implemented in a vertically disintegrated industry structure was viable in the early stages of the development of the Internet. With the traffic increasing, however, this system encouraged facilities-based companies (telcos) to cover high costs related to the operation and management of the Internet networks while, at the same time, facilities-less companies (ISPs) were using these backbones for a free or a minimum amount of money, and were charging customers (except for free Internet ISPs which relied on revenues generated by advertisement or connected and cross activities) for the services they provided on the final market. This situation finally provided telcos with the incentives to eliminate the double marginalization problem by resorting to vertical integration, although this occurred with a delay, namely only over period (2). However, even if transitory, period (1) was not minor. Facilities-less ISPs largely contributed to the diffusion among end-users of a major innovation (the Internet) and clearly outperformed telcos in this business activity. Moreover, they provided customers with a large spectrum of new services, with or without charges. In this context, period (1) was not characterized by sub-optimality, either for competition which occurred among many new and innovative players, or for customers which had become familiar with a new medium, the Internet.

This drives us to the second assumption which may clarify the gap which results from the confrontation. When strategic behaviors are high and information on demand is imperfect, the vertical contractual relations literature stresses that there may be an arbitrage between vertical integration and vertical specialization (or 'joint-profit versus dampening-effect-of-competition' dilemma), and that vertical integration would be more efficient if there were a dominance of information over price competition problems. The second assumption would

[16] In contract theory, this pricing regime is considered as an approximation of a first-best optimum which should be obtained by the achievement of a level of prices equal to the level of marginal costs.

then be to consider that, in this specific case, price competition dominated information problems. However, from what occurred within this period, it remains difficult to sustain the argument that competition concerning the Internet connectivity was exclusively driven by prices. Though the development of free Internet charges was for some firms a key for success, in the meantime many of them tried to differentiate themselves and offer a large spectrum of associated services, beyond the basic and standardized end-to-end connectivity services. Moreover, information problems were omnipresent and cannot be neglected in period (1): the development of many ISPs/IAPs was favored by a greater ability to capture market opportunities (compared to telcos), presumably generated by a better information on potential demand.

Finally, the third hypothesis is that ISPs/IAPs developed new activities related to the discovery and estimation of future wants for the Internet, and took advantage of distinctive capabilities in the Internet Protocol to propose a radically new approach for communications. In a sense, the circuit-switched activities and related capabilities which were accumulated for years by telcos were progressively contested by new systems of communications, based on packet-switched activities which were at that time essentially used in the computer industry. The ISPs/IAPs favored the early convergence of activities between the telecommunications and the computer industry, while telcos continued to operate on the basis of their existing set of activities and related capabilities[17].

b) Comments on period (2)

Over period (2), there is a coherence between observed vertical structure and optimal vertical structure. In fact, the peering system was increasingly questioned in a context where the asymmetry between the different companies' networks was becoming increasingly important, this asymmetry concerning the upstream facilities-based telcos and the downstream facilities-less ISPs. The presence of extra profits generated by ISPs/IAPs at the downstream level, together with a better knowledge of these firms on final demand, finally induced upstream firms (after a phase of inertia on period (1)) to eliminate the double marginalization problem, as well as the informational rent. However, in this case, theoretical results exhibit no

[17] Fransman (2001) states that this is a key element of the transformation of the 'old telecommunications industry' to the 'info-communications industry'. Especially, "(…) the innovation system in the info-communications industry differs fundamentally from that which existed in the old telecommunications industry. To begin with, in the info-communications industry the innovation system is open in the sense that virtually

sufficient vertical restraints, while in practice complex interconnection agreements were indeed implemented (such as interconnection agreements based on Total Element Long Run Incremental Cost, or Efficient Component Pricing Rule), and were highly favored by regulation and competition authorities which envisaged vertical integration as a 'too radical' solution. Moreover, this trend of vertical integration produced a standardization of the Internet services offered (essentially the basic, standardized end-to-end connectivity), as telcos generally acquired relatively small ISPs, while large, diversified and content-embedded ISPs exited Layer 3 to consolidate their activities on Layer 4 and Layer 5, as independent players. In this context, vertical integration did not necessarily improve customers' welfare, except if customers preferred standardized services. Finally, decreases in final prices which are generally observed within an optimal vertically integrated structure has not been the outcome of the observed vertical integration. Telcos generally charged the Internet services they provided, involving thus a negative impact on customers' surplus. As a matter of fact vertical integration which was sustained by theoretical results did not necessarily produce in practice the expected characteristics of the optimal structure.

c) Comments on period (3)

In this case, a gap emerges again between observed and optimal vertical structures. The first assumption is that this trend towards vertical specialization is highly context-dependent, and corresponds to the reorganization of existing activities related to increasing financial constraints. In fact, an important element is that many telcos decided to reorganize their Internet activities into new independent entities to raise capital from financial markets, generally to alleviate debts accumulated in other segments of activities or generated by costly acquisitions. As such, the increasing dependence of the Net economy towards investors and financial markets was not neutral in the process. Moreover, this vertical disintegration also appeared as a means to re-introduce differentiation in Internet activities and services. The end-to-end connectivity provided over period (2) being considered as a basic and standardized commodity, newly-disintegrated ISPs complemented their offerings over period (3) by other value-added activities and services. For instance, Wanadoo merged recently with Freeserve, a company specialized in free end-to-end connectivity activity, but Wanadoo also provided customers with value-added services such as directories, yellowpages, etc. The joint-product of this first assumption is that period (3) is basically a transitory period. For instance,

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anyone can create innovations within the industry. In marked contrast, in the old telecommunications industry the innovation process was open only to the monopoly operator and its favored suppliers" (ibid, p. 35-36).

customers who now have a preference for differentiated offerings may over time privilege one-stop shopping and, in this case, vertical integration could re-emerge. The increasing dependence towards financial markets may also produce the re-integration by telcos of their most value-added activities.

The second assumption is that double marginalization versus price competition is only one element explaining the choice between vertical integration or specialization. Other elements may complement the argument, and sustain a different vision of the current convergence towards vertical specialization. Apparently, two complementary sets of activities emerge from the recent restructurings that occurred within the info-communications industry. Telcos (British Telecom, France Telecom, Deutsche Telekom) focus on their core-activities which are the development/operation/management of the network infrastructure while vertically disintegrated ISPs/IAPs (BT Openworld, Wanadoo, T-online) tend to focus on the provision/commercialization/distribution of Internet services. At the moment, the observed vertical structure cannot be considered as sub-optimal or transitory. Vertical disintegration involved an important reconfiguration of the pre-existing vertical structure of the industry. Compared to period (2), the transition from vertical integration to vertical specialization did not produce increases in prices, but rather increases in service diversity. For instance, vertical disintegration favored the development of new alliances and partnerships dedicated to elaborate new activities and services (see Wanadoo and Orange which jointly created an incubator, called Invent Mobile, to configure new Internet applications for 3G mobile phones).

Navigation, software/middleware and content companies

Observed vertical structure versus optimal vertical structure

Periods	Observed vertical structure	Optimal vertical structure
Period (1) **From mid 1990s to late 1990s**	Vertical Specialization	Vertical Integration (without Sufficient Vertical Restraints)
Period (2) **From late 1990s**	Vertical Integration	Vertical Integration (without Sufficient Vertical Restraints)

Table 6: Vertical structures experienced in Layer 3, Layer 4, and Layer 5

In this case, observed vertical structure is different from optimal vertical structure over the first period. Nevertheless, in the second period, there is a global convergence towards vertical integration (Table 6).

Comments

a) Comments on period (1)

The gap between observed and optimal vertical structures can be explained by different elements. The first assumption is that over this period, navigation and software/middleware activities were separated from content activities. In other words, period (1) represents to some extent a pre-competitive stage, and the different industries that were concerned with these activities were not yet closely connected. In such a context, the second assumption is that arguments emphasizing the presence of a double marginalization problem or the existence of price competition are questionable because, at that time, there was no clear domination of one specific industry (or level) over the other for final markets.

b) Comments on period (2)

In the second case, vertical integration supported by mainstream economic models is also observed in practice. Nevertheless, the analytical rationale does not fit perfectly. For instance, the domination of one level over the other in terms of pricing strategies in the final market is still not evident, while this is a crucial assumption in mainstream economic models. Moreover, the costs involved by vertical integration cannot be neglected, as market capitalization of firms involved in Layer 4 and 5 are generally high. Finally, a significant bias appears because firms which initiated these consolidations of activities between Layer 4 and Layer 5 did not operate initially within these layers (AOL was formerly involved in Layer 3, Vivendi was formerly involved in Layer 2 via mobile telephony). Apart from these limitations, is it still possible to assume that vertical integration was essentially dedicated to solve double marginalization and information problems at the downstream level? To sustain this assumption, evidence should be provided that firms such as navigation and software/middleware, information and content companies (the downstream level in this case) generated extra profits or had a better knowledge of customers' attempts concerning new technologies coming from the info-communications industry. Nevertheless, AOL and Vivendi (here, thus, the upstream level) already have a large customer base, with a large spectrum of different services, and because demand is still highly volatile in this domain, it remains difficult to assume that some firms have a privileged access to information on final demand.

Rather, this type of acquisitions appears as specific attempts to make viable a (highly uncertain) innovation by the step by step articulation of vertically related activities and associated (complementary) capabilities. In fact, the Internet and associated (safe and multi-content) applications appear as a major innovation the implementation of which requires a close coordination of the different firms located in different layers. As such, vertical integration seems to provide such a coordination, and favors the convergence of the end-to-end connectivity activity with more value-added activities such as navigation and content activities.

5. Conclusion

Focusing on the vertical structure of the industry, this paper intended to stress that differences in terms of methodology are not anecdotal, since they strongly shape the results of the different frameworks. While empirical knowledge is used as an application of a pre-existing theory in conventional economic models (deductively-oriented), it is on the contrary a source of discovery which is intended to shape step by step the understanding of industry in the evolutionary approach (inductively-oriented). These methodological differences have moreover sound implications for the research agenda which has to be developed for the understanding of the evolution of the info-communications industry. At least three key issues, neglected by mainstream economic models, emerged from the present analysis in terms of the evolutionary layer model.

- There is a necessity to depict how the historical process drives the evolution of vertical structures. Vertical integration within AT&T (Layer 1 and 2) in the pre-liberalization period, or ISPs/IAPs' vertical specialization (Layer 3) sustained by the peering system in the early phases of development of the Internet, for instance, cannot be fully explained and analyzed without the historical and evolutionary background.

- The analysis of how vertical structures favor the development of innovations by providing the adequate coordination of different capabilities developed by different firms, involved in different layers. The paper stressed that vertical specialization of equipment suppliers (Layer 1) favored the refocusing of their capabilities and gave them the opportunity to become key actors in the industry. In the meantime, vertical integration in downstream layers of the

industry (Layer 3, 4, and 5) seemed to strengthen coordination between firms in order to develop new applications related to high speed Internet and 3G mobile phones. Rather than focusing on optimal vertical structures, which are necessarily time and context dependent, the proposed evolutionary analysis centers on how each vertical structure contributes to economic change.

- The understanding of how vertical structures sustain competitive processes by imposing recurrent restructurings in the existing industrial structure (entry/exit), and modifications in market conditions (standardization/differentiation). Specialized equipment suppliers (Layer 1) stimulated entry and competition downstream (Layer 2), and further diversity in applications for final demand. In the meantime, the evolving process of integration/disintegration between telcos and ISPs/IAPs (Layer 2 and 3) may reduce this diversity and transform these applications into basic commodities. The evolutionary analysis does not consider competition as an outcome or as a state of affairs but, rather, as a process which is highly and recurrently influenced by the vertical structure of the industry.

Different key elements were unfortunately omitted from the analysis presented in this paper. For instance, the role played by financial markets and governance in the processes of vertical specialization/integration was only a latent theme, though it appears today as a crucial element in the massive process of mergers and acquisitions, eventually involving misconduct in terms of accounting (vide Worldcom). The changing nature of customers' tastes and preferences, which is much debated today in economics and strategic management approaches, certainly deserved a more detailed examination. Finally, the analysis of dominant trends in vertical specialization/integration was privileged against the detailed understanding of the decision-making processes by which the industry's key actors decode what occurs within the industry, and in the light of their own perception, adopt (what they believe is) the appropriate vertical specialization/integration strategy. These elements, without doubt, constitute key issues for researchers concerned with the analysis of the evolution of the info-communications industry, and strongly structure their future research agenda.

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